The OVIRS Visible/IR Spectrometer on the OSIRIS-Rex Mission

International Workshop on Instrumentation for Planetary Missions

October 11, 2012

Dennis Reuter and Amy Simon-Miller
GSFC Code 693
301-286-2042
dennis.c.reuter@nasa.gov

OSIRIS-REx

- Origins Spectral Interpretation Resource Identification Security Regolith Explorer
  - Third New Frontiers mission
- Sample return from asteroid 1999 RQ36
  - Primitive B-type carbonaceous asteroid, a class that has never been studied up close
- Scheduled for launch in Sept 2016

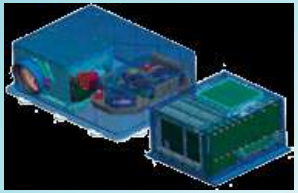
INSTRUMENTS SUPPORT SAMPLE RETURN BUT ALSO ENHANCE SCIENCE

- OSIRIS-REx Camera Suite *(OCAMS)*
  - (UA): Provides long-range acquisition of RQ36, along with global mapping, sample-site characterization, sample acquisition documentation, and sub-cm imaging

- OSIRIS-REx Visible and IR Spectrometer (OVIRS)
  - (GSFC): Provides mineral and organic spectral maps and local spectral information of candidate sample sites from 0.4 - 4.3 µm

- OSIRIS-REx Thermal Emission Spectrometer (OTES)
  - (ASU): Provides mineral and thermal emission spectral maps and local spectral information of candidate sample sites from 4 - 50 µm

- OSIRIS-REx Laser Altimeter (OLA)
  - (CSA): Provides ranging data; global topographic mapping; and local topographic maps of candidate sample sites



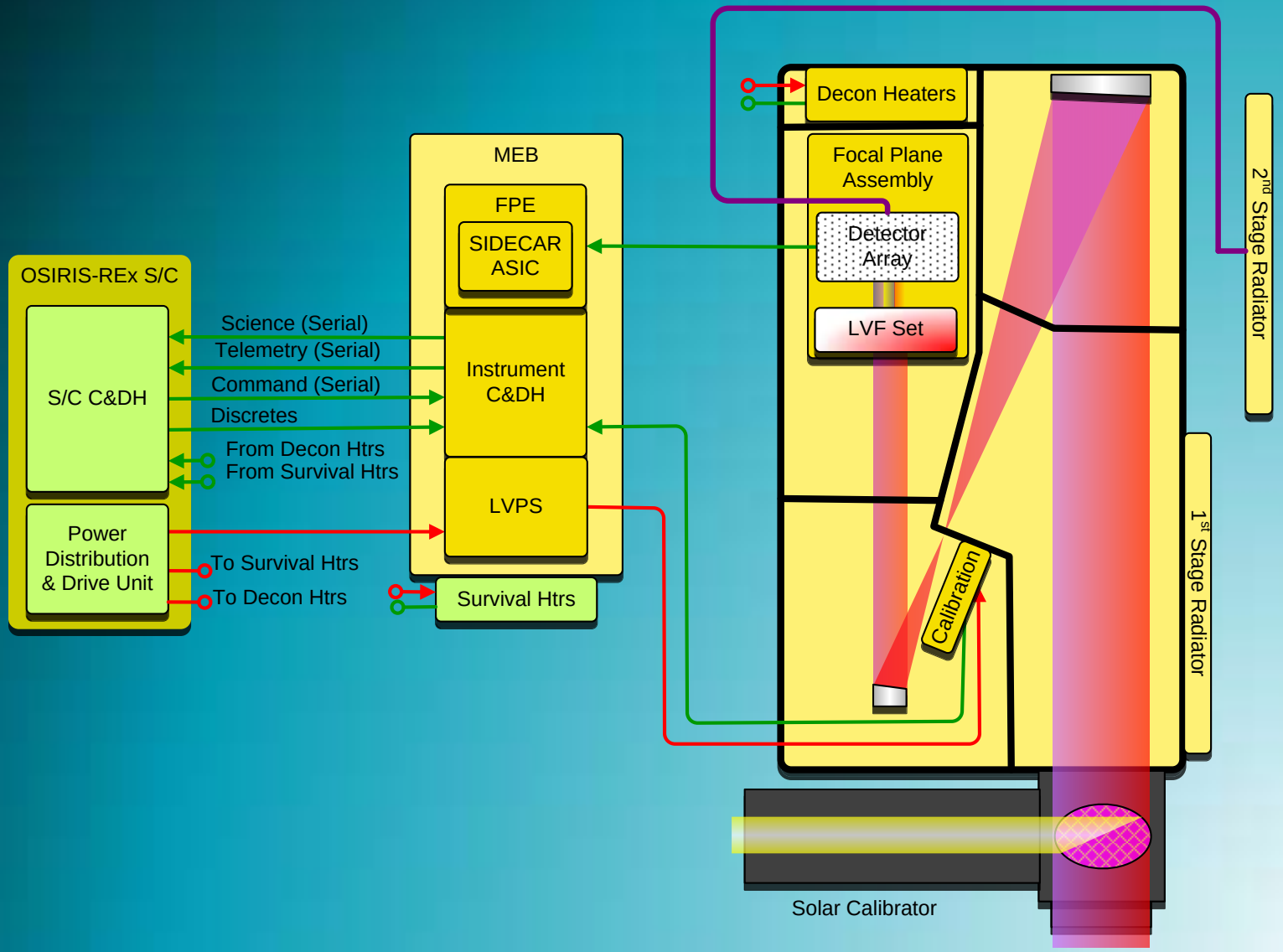
OVIRS Concept Overview

- Visible-Near IR Spot Spectrometer
- Use Linear Variable Filter (LVF) approach
  - 2-D filter in which the pass-band wavelength varies in 1 dimension
  - Filter placed directly over 2-D array
  - Spectral resolution and band optimized for application
- Spectrometer builds on flight heritage of New Horizons Ralph/LEISA instrument
  - Passive cooling
  - Aluminum Structure and Mirrors for Athermal Design
- Simple 2-Mirror Optical System
  - Afocal focal plane

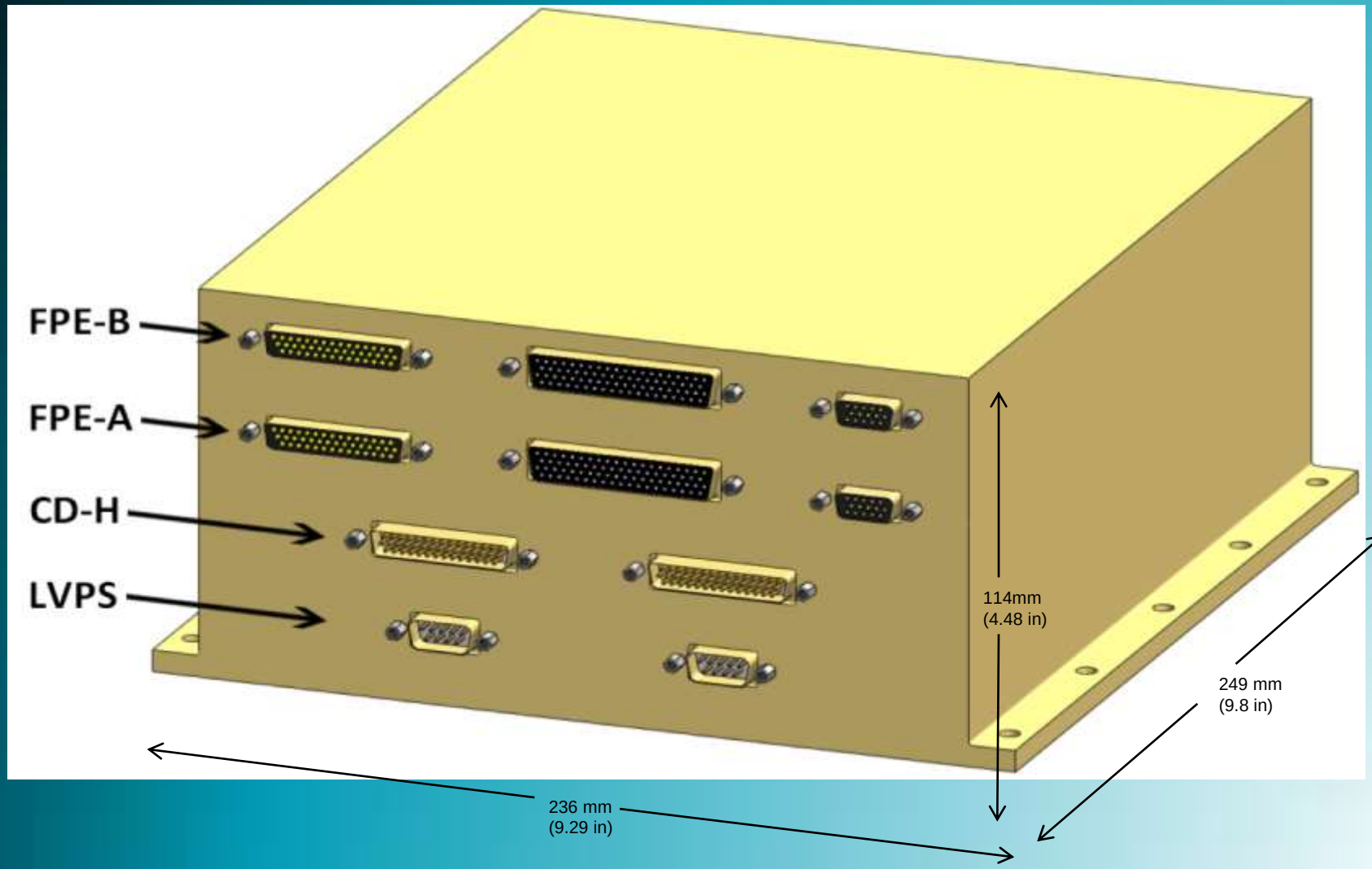
OVIRS DESIGN OVERVIEW

- Passively-cooled point spectrometer (0.4 to 4.3-microns)
  - Optical design draws from New Horizons Ralph (LEISA). Similar design and layout, but simplified
    - H1RG detector heritage: HST WFC3, OCO, WISE
      - Only require 512 x 512 quadrant, uses WISE 4.2-μm cutoff array substrate removed HgCdTe
    - SIDECAR ASIC: GSFC experience with JWST, HST ACS, LDCM TIRS
  - 4-millirad FOV
    - Easily modified for 1 – 2 milliradian
  - 2-meter surface resolution @ 0.5-km altitude sample site reconnaissance phase
  - Four linear variable filter segments (baseline, will be tuned after contract awarded)
    - 0.4 to 0.9 μm: resolving power ($\lambda/\Delta\lambda$) = 125 (max 7-nm resolution, 200 cm^{-1} @ 0.4 μm)
    - 0.9 to 2.0 μm with resolving power = 150 (max 13-nm resolution, 75 cm^{-1} @ 0.9 μm)
    - 2.0 to 4.3 μm with resolving power = 200 (max 22-nm resolution, 25 cm^{-1} @ 2.0 μm)
    - 2.9 to 3.6 μm with resolving power = 350 (max 10-nm resolution, 10 cm^{-1} @ 2.9 μm)
- Operations/Modes:
  - On (14 W)
  - Decontamination (20 W for decon heaters)
  - Calibration (+2 W for cal lamps)
  - Off (5 W for survival heaters)

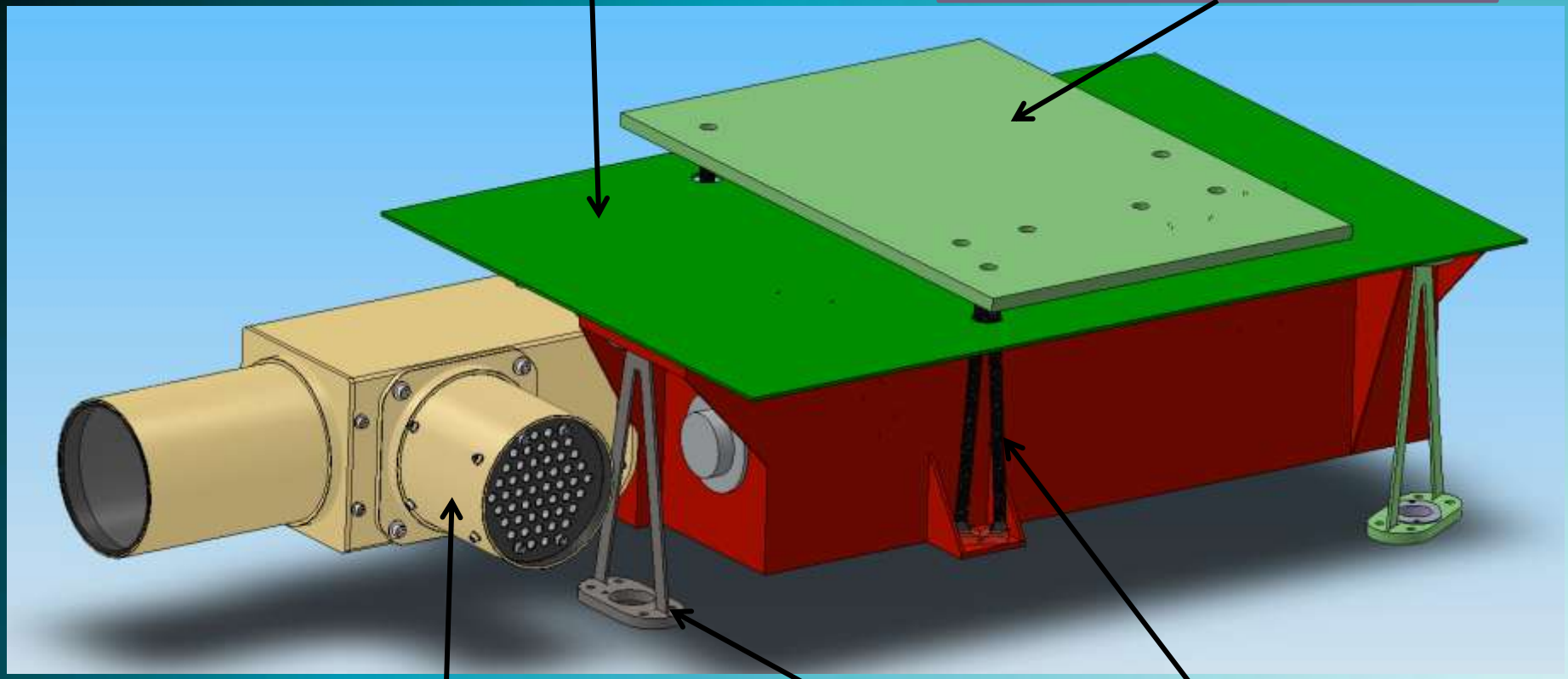
Functional Block Diagram



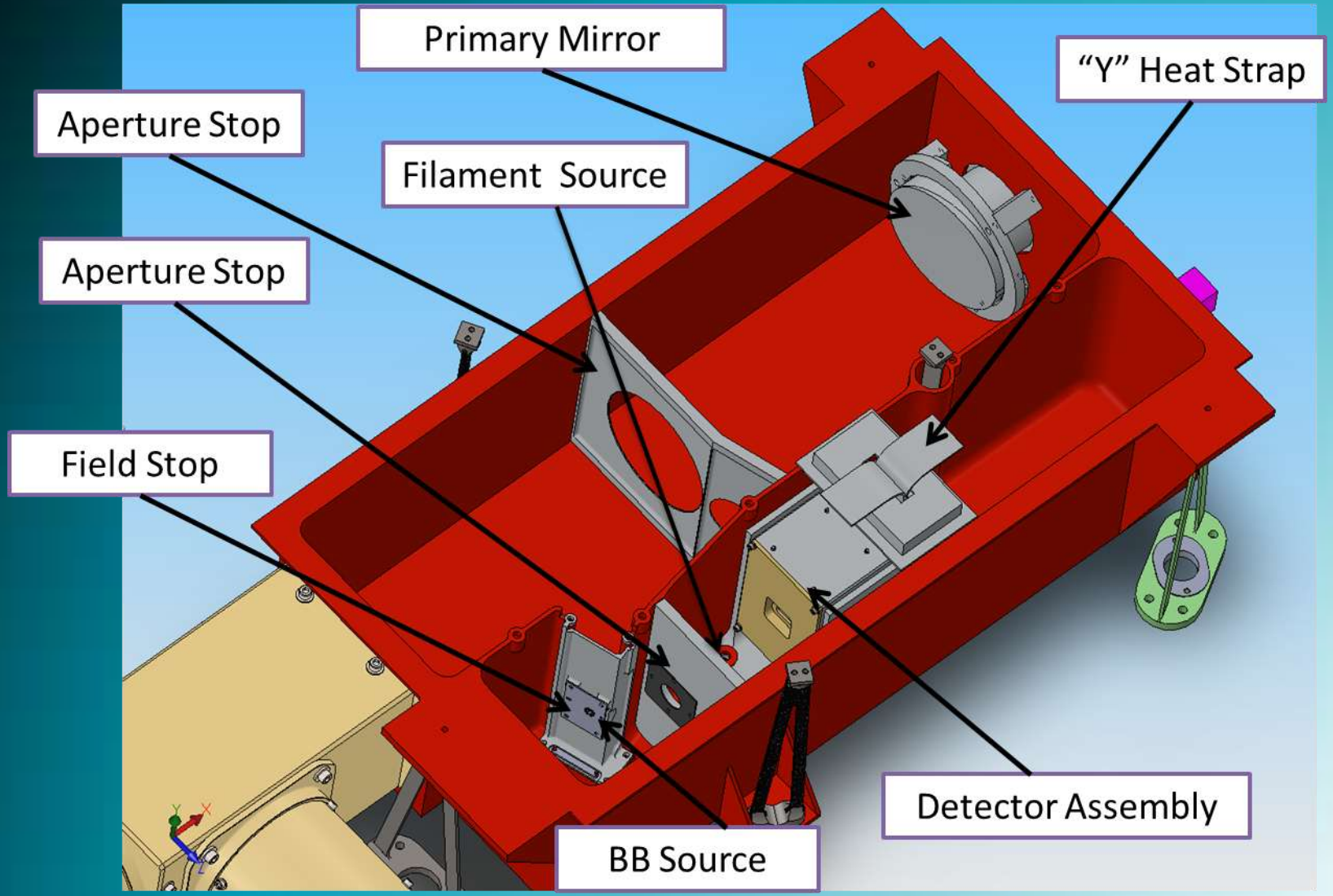
OVIRS Main Electronics Box (MEB)



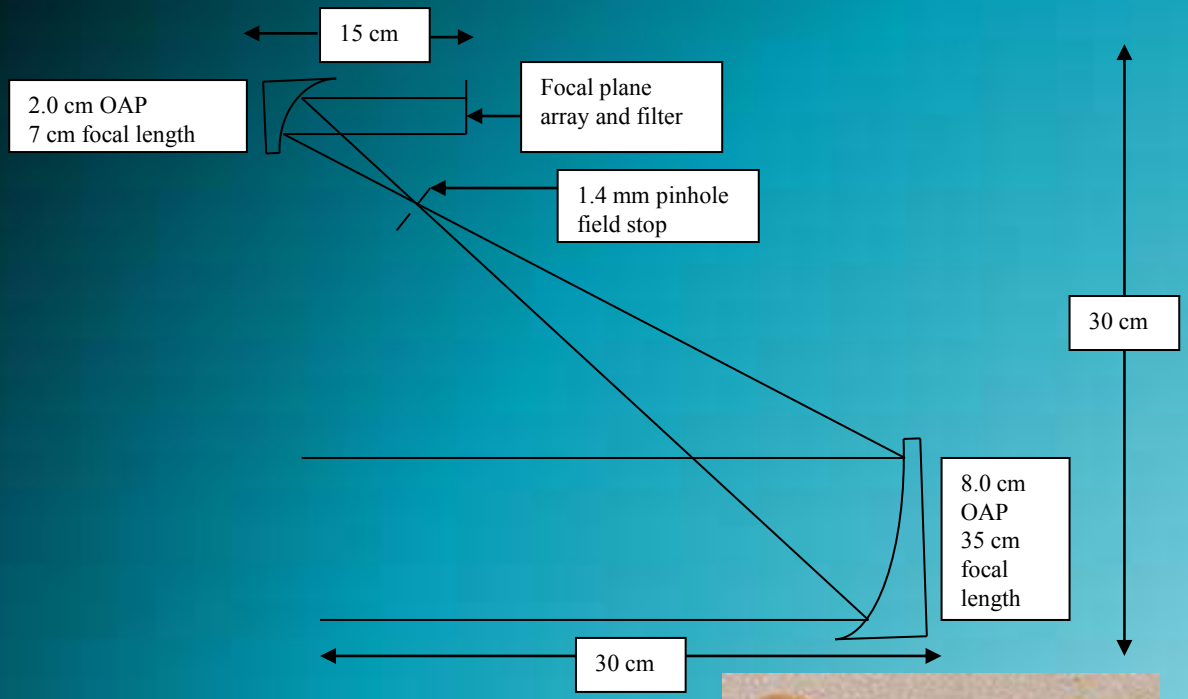
OVIRS OPTICS BOX

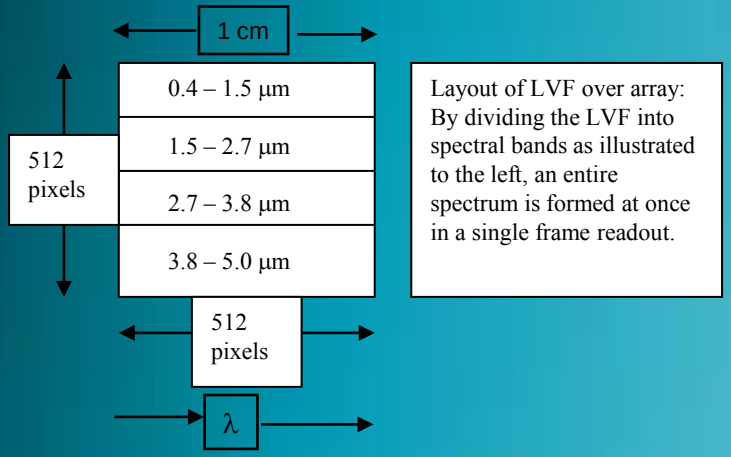


OVIRS INTERNAL VIEW

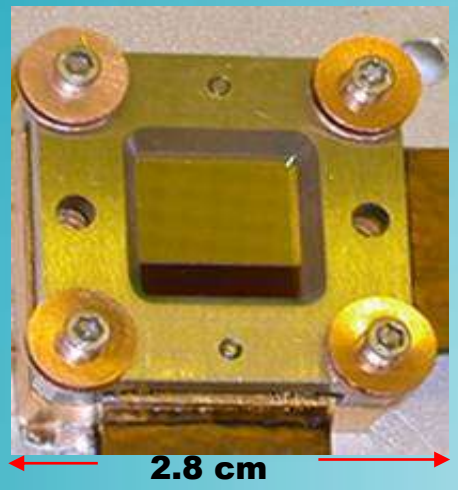


Extremely Simple Optical Design



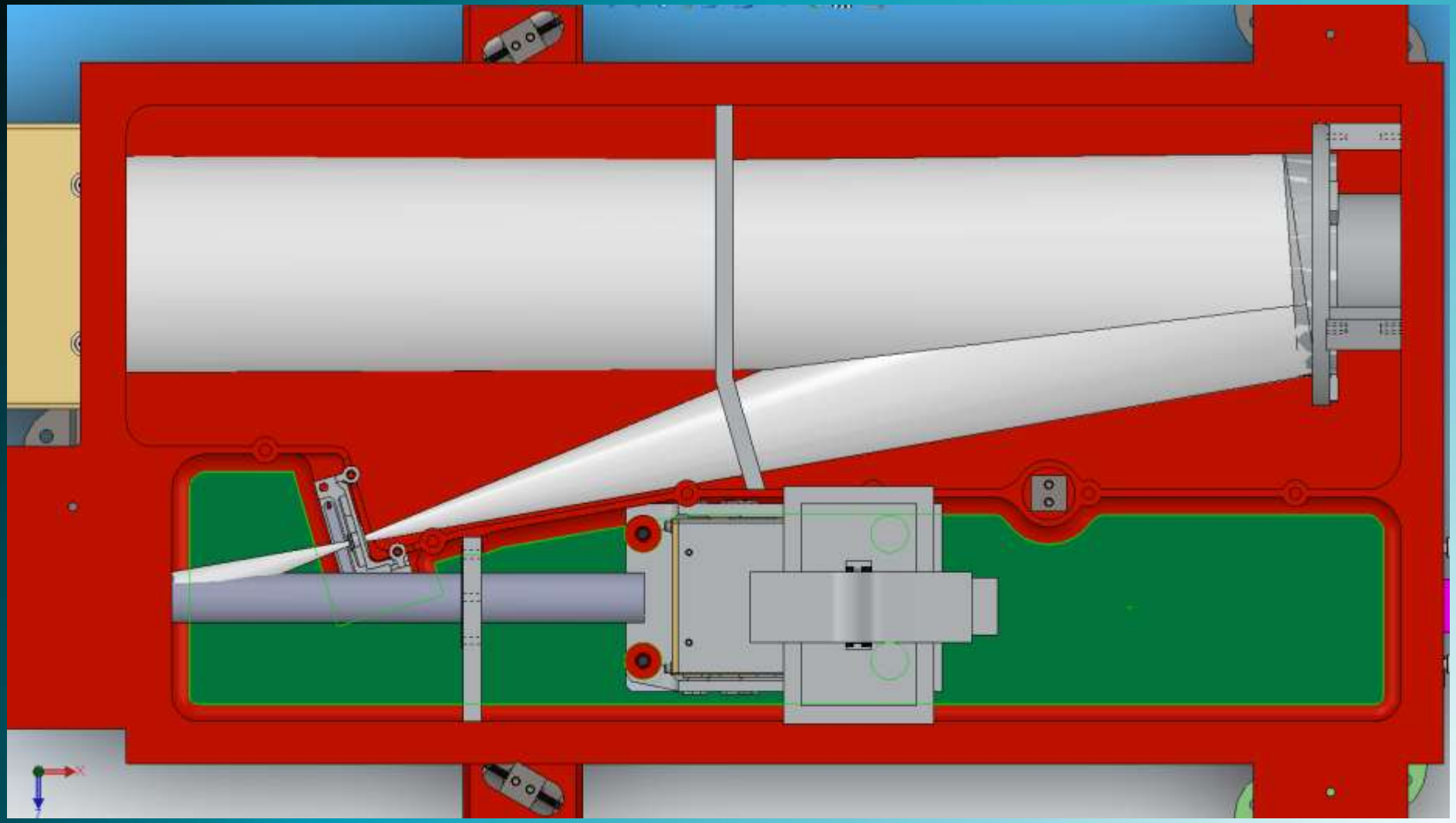


Layout of LVF over array: By dividing the LVF into spectral bands as illustrated to the left, an entire spectrum is formed at once in a single frame readout.

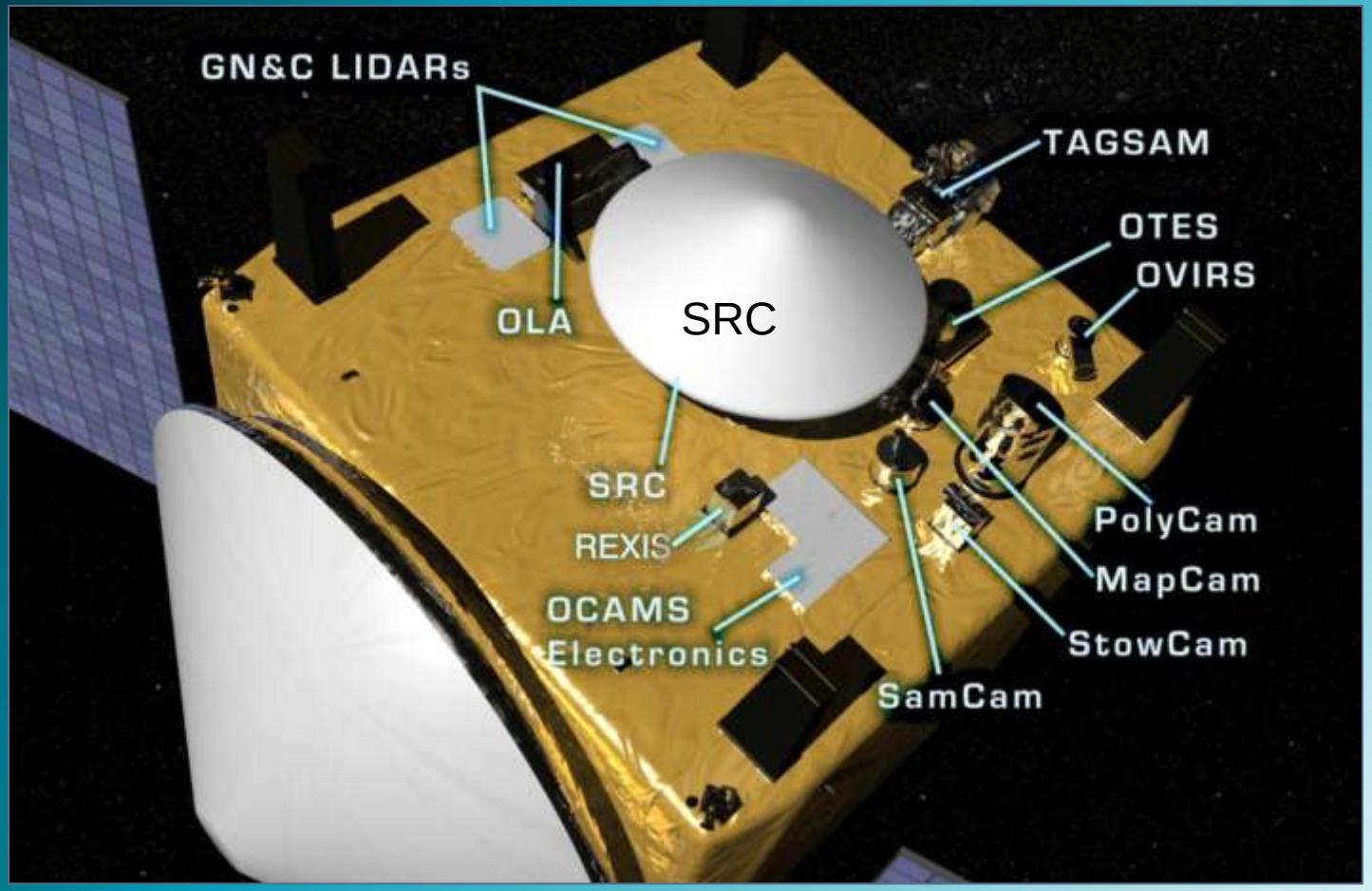


- **1 AU Heliocentric Distance**
- **Close Proximity of Spacecraft**
- **Allows trade of efficiency for simplicity**
- **Example: New Horizons LEISA focal plane**

OVIRS Beam Path



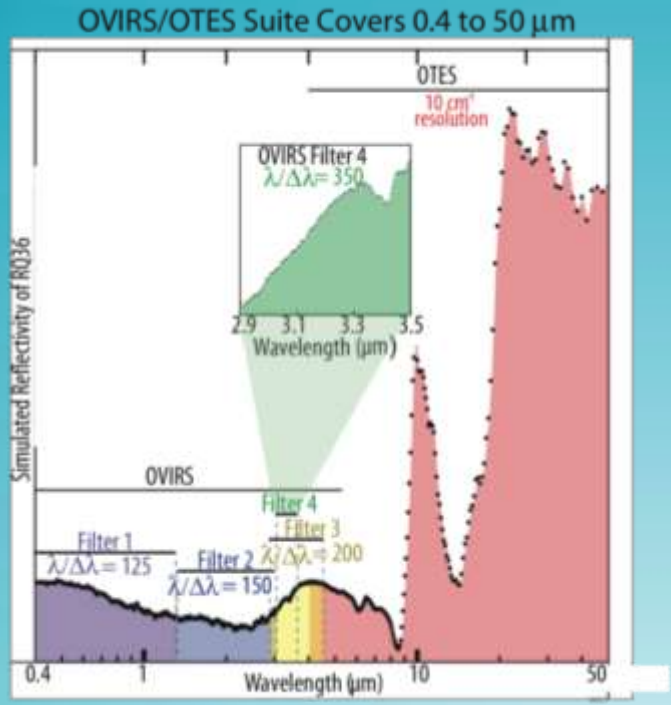
INSTRUMENT SUITE LAYOUT



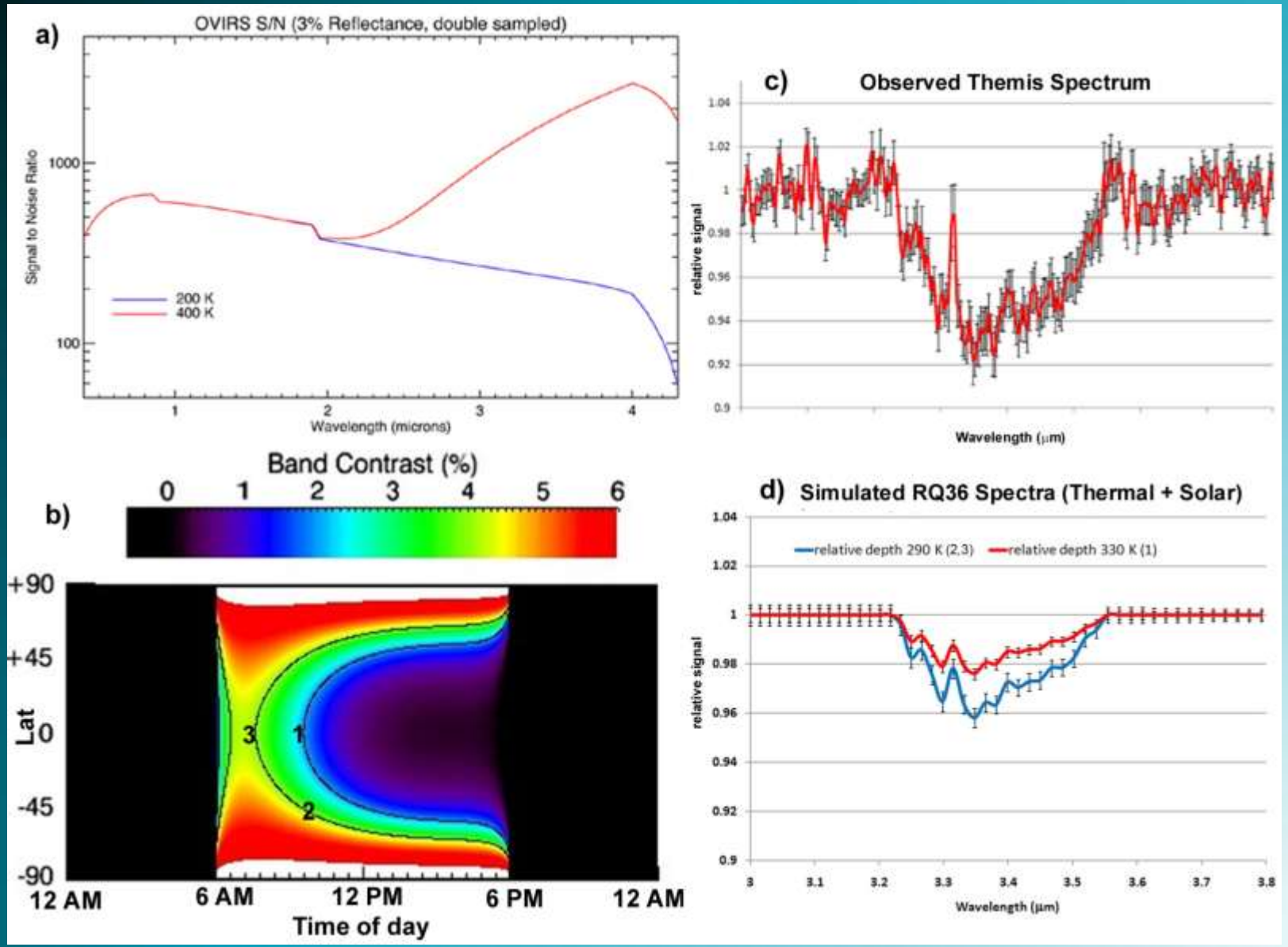
OVIRS ENHANCES SAMPLE RETURN SCIENCE

From approach to sample site characterization (144-km to 30-m range), OVIRS:

- Obtains 0.4 to 4.3-µm spectra, diagnostic for mineralogy and organics
  - Produces, with OTES, unprecedented global visible/IR surface inventory
    - Provides geological context for returned sample
    - Documents scale of surface variability
    - Characterizes space weathering and impact history
    - Constrains Yarkovsky effect thermal emission and solar reflection contributions
- Informs choice of sample site selection and provides context
- Provides connection between ground-based observations and *in-situ* measurements



SPECTRA DEPEND ON REFLECTION AND EMISSION

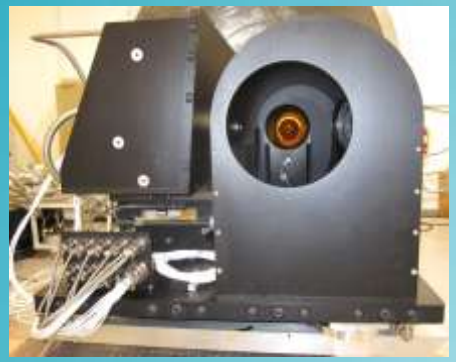


IN-HOUSE I&T AND CALIBRATION REDUCES RISK

The Detector Characterization Laboratory (DCL) – Focal plane testing and characterization

EMI/EMC Test chamber

GSFC Vibration test facility in Building 7



Visible/ Infrared in-chamber NIST traceable calibration facility

Thermal/vacuum test facilities